



Renewable Energies

‘Guidelines for Technical Specification, Performance, Implementation and Operation of MLBGPs under the ADB loan’

附件4B 亚行贷款大中型沼气项目设计、操作、实施及运行技术规范指南

**Prof. Dr. Bernhard Raninger, Technical Project Director
Beijing, 14th of May 2010**

GTZ Training for DESIGN Institutes II



Agenda / 议程

1) Current Status of MLBGP in China

中国大中型沼气工厂当前状况

2) Introduction of SINO-GERMAN Optimization of Biomass Utilization Project (GTZ-FECC)

中德生物质能优化利用项目介绍

3) Requirements on MLBGP Plant Design and Operation

大中型沼气工厂设计与运营操作



Definition of Middle- and Large-Scale Biogas Plants in China (National Standard NY/T 667-2003) / 中国大中型沼气工厂定义（国家标准NY/T 667-2003）

BGP size 规模	Individual Fermenter Size (m ³) 发酵罐容量	Biogas Production (m ³ /d)* 沼气产量
Large 大	≥ 300	≥ 300
Middle 中	≥ 50 - 300	≥ 50
Small 小	≥ 20 - 50	≥ 20

Basically all plants must have: 基本上所有的工厂必须都有:

- i. **input and output measurement** 进料和出料
- ii. **feedstock pre-treatment** 原料预处理
- iii. **slurry use or processing** 沼液沼渣使用或者加工
- iv. **biogas storage, purification and utilisation.** 沼气存储, 净化和使用

中国在小型生物厌氧罐方面非常有名。（2009年3千万）**China is famous for small scale household scale bio-digesters (30 mn in 2009)**



MLBGP Wei Wei, Milk Cattle Farm Jiangsu MLBGP 江苏维维食品饮料股份有限公司



NDRC Demo Project
示范项目
2,500 milk cows 2,500头
乳牛
5,000 t/yr 5,000 吨/年
2,500 m³ USR
2,500 m³ USR
0.5 MW CHP
当地沼气管网 (350个农民)
2006
Ecofertilizer
生态肥





MLBGP at DaNiu Milk Cow Farm, Liaoning Tieling

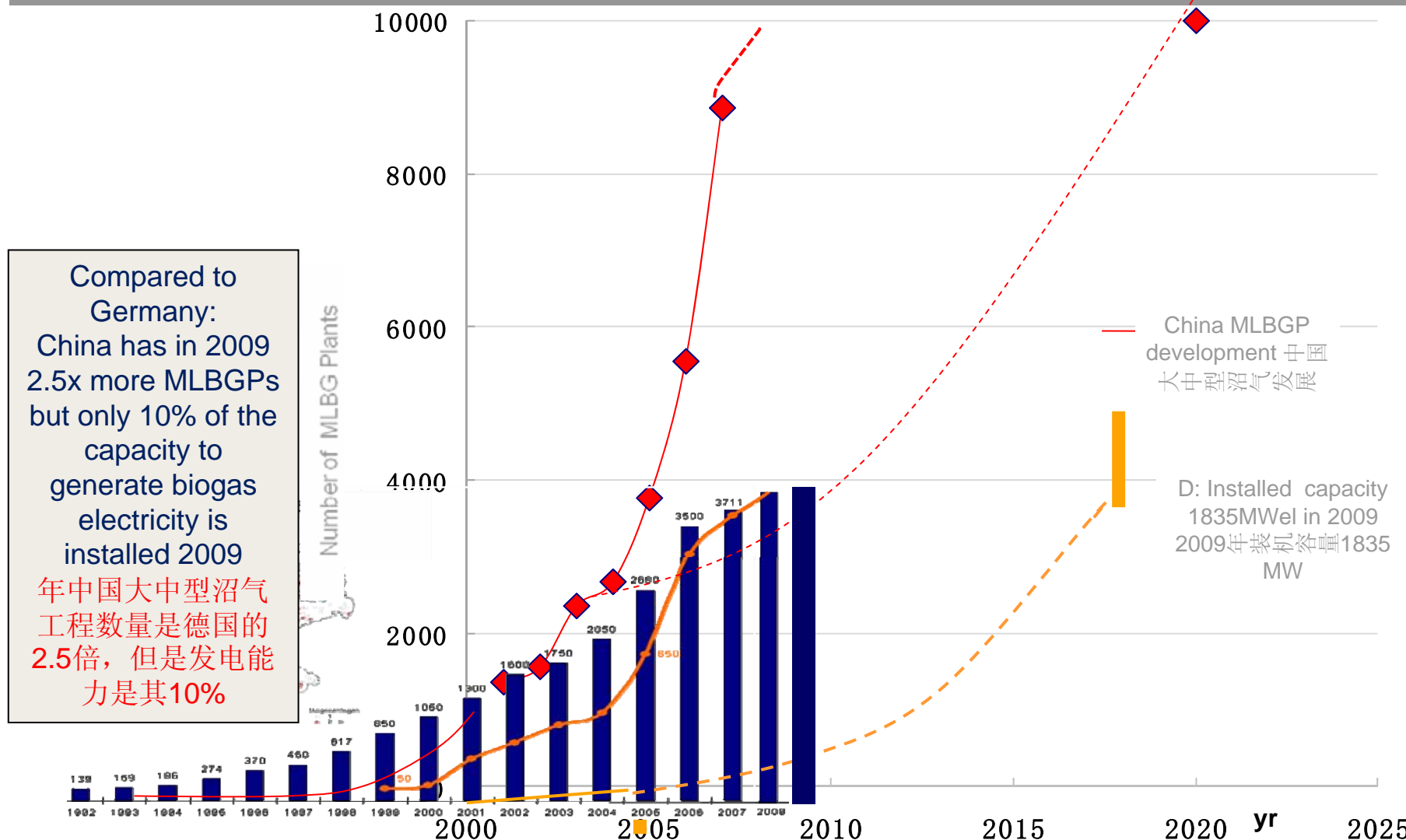


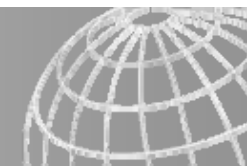
Demo Project
1st phase
2000 dairy cows
4000 t/yr
1 x 2000 m³ CSTR
150 kW_{el-instal}
Invest: 6 mio RMB
2009





MLBGP development in Germany 1992–2008 & in China till 2007, forecast 德国 (1992 – 2008) 与中国 (直到2007) 大中型沼气项目开发比较, 2020预测



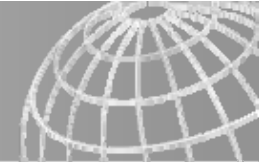


3 registered CDM Agricultural Biogas Projects in China (UNFCCC 4/2010)

中国已注册的3个CDM的农业沼气项目 (联合国气候变化框架公约 4/2010)

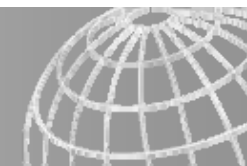
Project Name 项目名	Project type 项目类型	Project owner 项目业主	UNFCCC registered GHG Reduction 注册 温室气体减排量	CER buyer 减排买家	UNFCCC status 状况	Success rate of CER 减排签发率
<u>Hubei Eco-Farming Biogas Project</u> <u>Phase I</u> * 湖北生态农户沼气项目 (第一期)	Methane recovery and utilization 甲烷回收利用	Hubei Qingjiang Zhongye Company 湖北清江种业公 司	58,444	IBRD as trustee of Community Development Carbon Fund 世界银行社区发展 碳基金	Registered 注册	
<u>Methane Recovery and Utilization</u> <u>CDM Project at Muyuan Swine Farm</u> <u>in Henan Province</u> 河南牧远猪场甲烷回收和利用项目	Methane recovery and utilization 甲烷回收利用	Muyuan Livestock Feeding Co.,Ltd. 牧原养殖有限公 司	110,461	Marubeni Corporation, Japan 日本丸红株式会社	1 st CER request 申请第一次 签发	6.6%
<u>Animal Manure Management System</u> <u>(AMMS) GHG Mitigation Project</u> , <u>Shandong Minhe Livestock Co. Ltd.,</u> <u>Penglai, Shandong Province, P.R. of</u> <u>China</u> 山东民和动物粪便管理系统温室 气体减排项目	Methane recovery and utilization 甲烷回收利用	Shandong Minhe Livestock Co.Ltd 山东民和养殖有 限公司.	67,443	IBRD as trustee of Community Development Carbon Fund 世界银行社区发展 碳基金	Registered 注册	

*33,000 Household small scale digesters (World Bank Project)



Challenges / 挑战

- The current performance of MLBPGs in China is highly unsatisfactory (National Statistical Handbook 2008, UNFCCC CDM status May 2009) 中国大中型沼气工程运行效率低下（国家统计局年报**2008**，至**2009年5月 CDM注册情况**）：
 - 4,000 MLBPP in China, **2007年共计4000大中型沼气工程**
 - Only 28 CDM projects in validation (2009) 仅有**28个CDM项目**在审核
 - Only 2 BGP CDM projects are registered and only 1 MLBGP can claims 9% of the anticipated **CERs** 仅有**2个CDM项目注册**且仅有**1个项目**申请签发**CERs**
- China needs 中国需要:
 - Environmental protection in the husbandry sector 畜禽养殖场环境保护
 - 15% Renewable energy 2020, incl. biogas (acc. RE –Law, 2006) 利用沼气作为可再生能源
 - enhanced CDM development capacities and to apply new/adapted methodologies (climate, feedstock,) 提升**CDM**开发能力，应用新的方法学（气候，原料，）
 - additional CDM modalities like ‘small scale bundling’, **PoA-CDM** 增加**CDM**开发模式如 **P-CDM**
 - application of international ‘best practice’ MLBGT technology I应用国际“最佳实践”大中型沼气工程技术
 - New business models (centralization and co-feedstock processing) 新的商业模式（集中式和联合原料处理）
 - Improvement of the business environment to develop MLBPGs 提升大中型沼气开发商业环境



MLBGP development in China (2005 – 2014) Impact of 154 ADB Subprojects

154子项目及11个核心子项目将产生的影响 中国大中型沼气工程的发展 2005-2014年

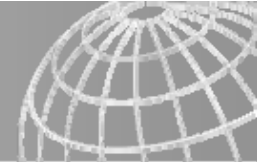
Performance of MLGBPs	[]	Total MLBGP performance 2005	Impact of 11 MLBGP core-subprojects after 2014	Increase by (%)	Impact of 154 MLBGP subprojects after 2014	Increase by (%)
Animal manure in all China	bn t/yr	2.1	0.002	0.1	0.01	0.5
Number of MLBG plants	n	* 3,764	11	0.3	154	5
Digester net-volume	m ³	* 1,724,100	46,500	2.6	322,000	18
Waste Treatment Amount	mn t/yr	* 122,820	1,969	1.6	9,500	8
Average treatment capacity	t/yr*plant	32,000	179,000	660	61,700	100
Biogas Output	mn nm ³ /yr	* 341	19.3	5.6	100,000	23
Biogas Supply to Households	mn nm ³ /yr	* 138	0.87	0.6	14.3	10
Biogas Power Generation	mn kWh/yr	40	29.7	43	121	200
Installed Capacity	MW	19.2	5	20	20	100
Commercial Eco-Fertilizer	mn t/yr	4.5	0.68	13	5.2	100
Increase of food crop value	%			10 – 20		10 – 20
GHG emission reduction	mn t CO ₂ /yr	7	0.090	17	> 1.2	17
COD emission reduction **	mn t COD/yr	7.8	>0.004	0.06	>0.4	0.56
CDM projects	n	0	6 - 11		120 - 150	
Employment ***	person	10,000	200	2	1,700	2.3
Indirect beneficiaries (households)	n		****>47,000		> 280,000	

* Source BIOMA, Chengdu Biogas institute, Wu Libin, 2006

** 2001 COD livestock emission all over China, 80% COD reduction assumed

*** construction workers not included

**** 47,000" refer to ecofarming beneficiaries (from investigation on core-subprojects), 280,000 come from ecofarming expert's report



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Overall Project Objective of the GTZ Biomass Utilization Project / 项目总体目标

The overall objective* of the GTZ Project is:

... to improve the technical standard and the (operational) performance of medium- and large-scale biogas plants that produce energy from biomass.

项目的总体目标在于：

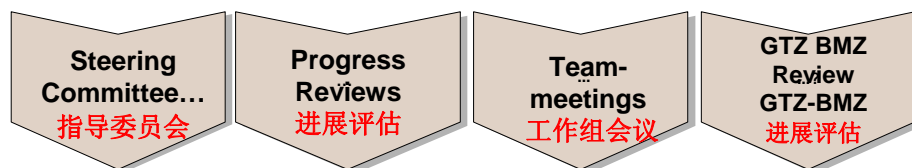
...**提高大中型沼气发电厂（利用生物质生产能源）的技术标准和运行水平**

* PIA 7/2009

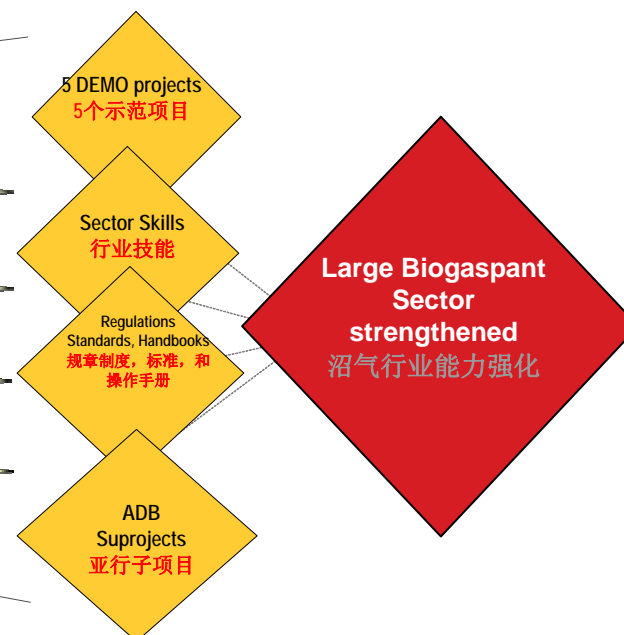


GTZ Process architecture & landscape 流程图

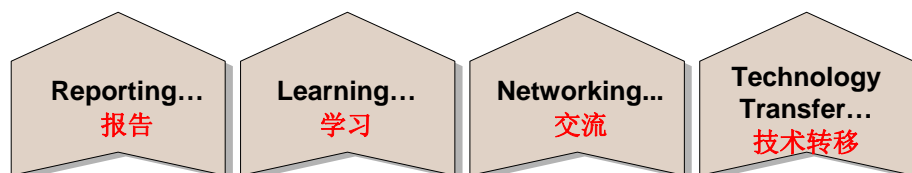
Steering processes 指导程序



Core processes 关键程序



Auxiliary processes 附属程序





组成部分 / Project Components

组成部分 **A**：对“最佳实践”示范项目的支持

Component A: Support to 'international best practice' demonstration projects

组成部分 **B**：进行能力建设，促进广范围推广和复制机制的形成

Component B: Capacity building and mechanisms to promote broader dissemination and replication

组成部分 **C**：行业政策框架

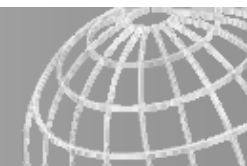
Component C: Sector policy framework

组成部分 **D**：对**ADB**项目实施项目管理办公室的技术支持

Component D: Technical support to the PMO for ADB Project implementation

组成部分 **E**：与国家发改委的其他活动。

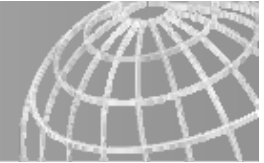
Component E: Other activities with NDRC



Short List of 19 Demo project candidates and 7 Demo Projects proposals (green)

7个示范项目短名单



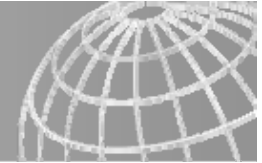


SINO-GERMAN Demoproject PPP Co-operation 中德合作示范项目合作内容（拟在谅解备忘录中规定）

Obligation of GTZ towards the Demo project owners:

GTZ对项目业主的义务:

- reviewing the **project concept** (FSR) acc. to ADB requirements 'NY/T 1222-2006' and the 'Guidelines for technical specification, performance, implementation and operation of MLBGP under the ADB loan [ANNEX 4b] 评估项目概念（可研），根据亚行要求及行业标准，“亚行贷款大中型沼气技术规格，操作，实施以及运行指南”
- review of **detail design**, workshop drawings 评估详细设计，图纸
- demonstration of **financial feasibility** of the adapted concept 评估采用方案的经济可行性
- specification of **equipment and project performance guaranties** for tendering 设备和运行担保详细说明（为招标准备）
- support of **tender evaluation** and contracting 为招标评估和签约提供支持
- supervision of **project implementation** 监督项目建设
- advise on **project start up and operation** during the first year 为项目启动和第一年运行提供支持
- providing **training** (planning, operation, maintenance, process monitoring,) 提供培训（设计，运行，维护，过程监测）
- support to facilitate the **cooperation with Investors, PPP- and CDM partners** 促进与其他投资方，公私合作伙伴和CDM合作伙伴的合作

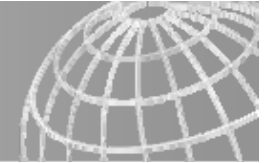


Obligation of GTZ towards the Demo project owners GTZ对项目业主的义务:

Scope of TA work

The International Consultant and the Chinese Domestic Engineering Consultants shall conduct advise and supervision on:

- 1. Preliminary and conceptual design, 3%
- 2. Basic- design and project preparation, 11%
- 3. Process design and blueprint, 15%
- 4. Approval design, 6%
- 5. Detailed design, 18%
- 6. Tender preparation, equipment specification 6%
- 7. technical and financial Tender evaluation and awarding, 5%
- 8. Construction supervision, 33% (delivery, implementation, start-up, final costs operations and maintenance manual)
- 9. Object documentation and warranty claims, 3% (list of faults and malfunctions, performance control and warranty claims, Final documentation, drawings, performance and emission monitoring



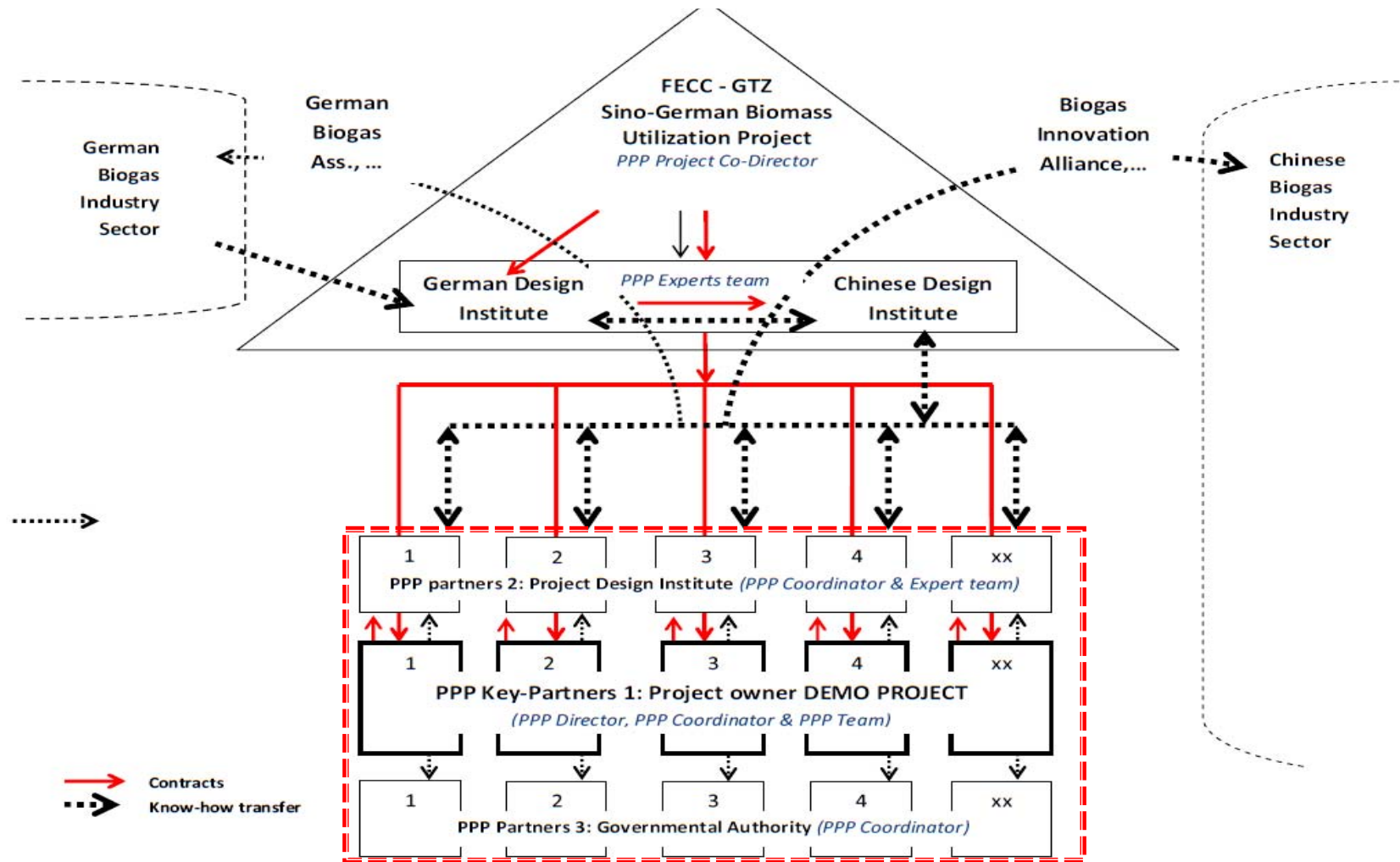
SINO-GERMAN Demoproject PPP Cooperation 中德合作示范项目合作内容（拟在谅解备忘录中规定）

Obligation of the Demo project owner 项目业主的义务:

- to provide a project implementation with matches the GTZ **project schedule** (detail design 2010 and first year of operation before 2013) 提供符合GTZ项目时间的项目实施计划（2010年详细设计，2013年前进入第一年运行）
- ensure smooth **cooperation with the design company** (MoU partner) 保证与项目设计公司的合作顺利（谅解备忘录中签约的合作伙伴）
- apply the technical concept proposed and possible additional investment required, based on the financial feasibility and common planner client negotiations under the **objective to develop a DEMONSTRATION project!** 按照成为示范项目的目标，在经济可行性及业主和设计方协商一致的基础上，应用GTZ提出的技术建议并增加相应投资
- Applying a **tendering procedure** acceptable to international procurement practice 根据国际程序实施招标
- **Implementation of project** by using the equipment as defined and tendered in terms of capacity, quality and quantity 按照招标文件规定采购合格设备（规格、质量和数量）以实施项目
- participate in the **trainings** provided 参加GTZ提供的培训
- not undertake any additional project cooperation which is in contradiction with the German Development cooperation or the selected business concept 不参与跟德国技术合作公司合作相冲突的其他合作项目

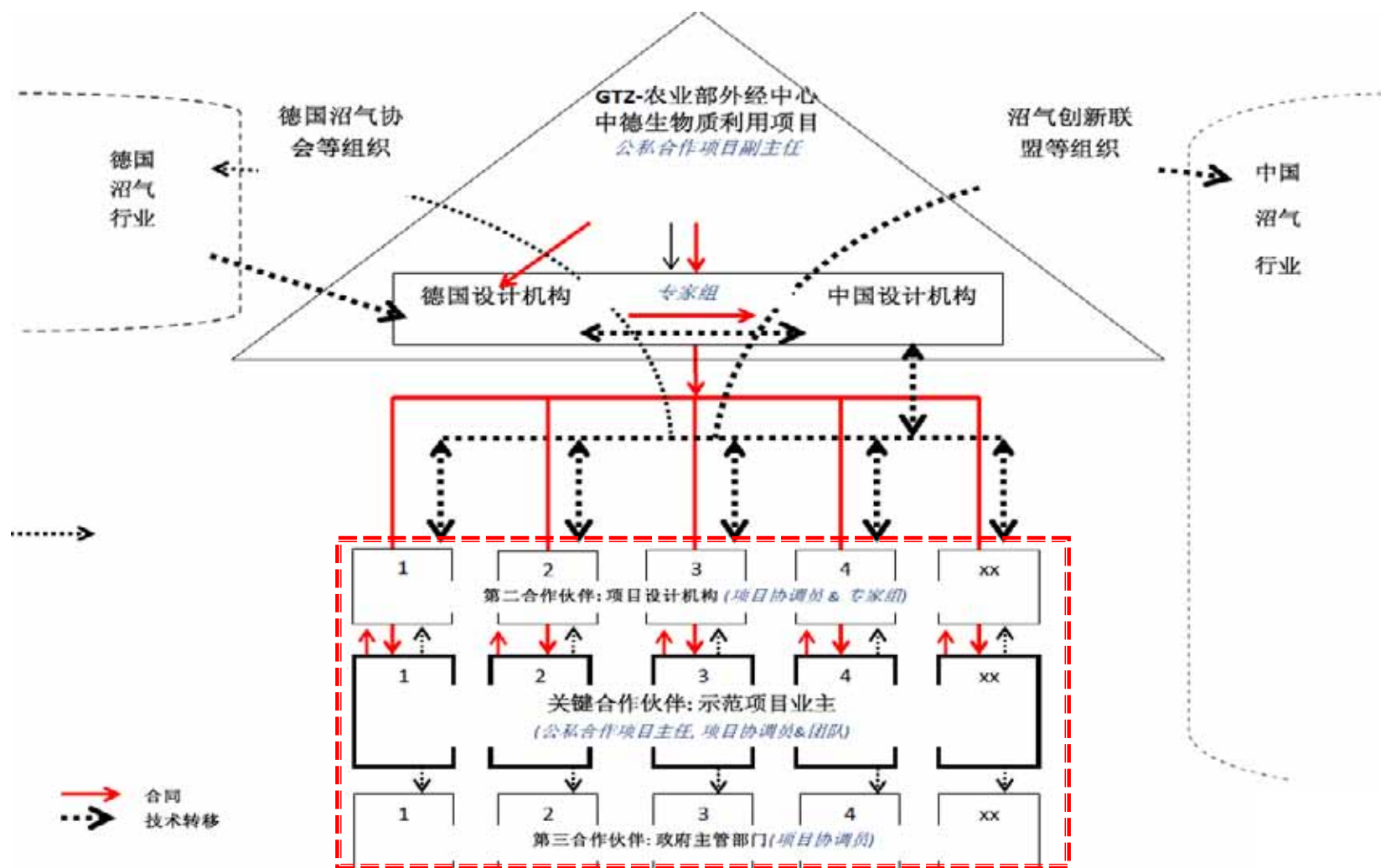


PPP Project Development of SINO – GERMAN DEMO Biogasplants





公私合作项目：中德沼气示范项目开发





对ADB项目整体支持 / Overall ADB Project Support

Component A: Demonstration projects (1-2 such as Shandong Lunan [GEF], Jiangxi Suichuan) **A部分：示范项目（1-2个比如山东鲁南及江西遂川）**

Component B: Training of designers, provincial TIOs, owners, operators, including study tours and onsite training in Germany as agreed in the PIA (on BGP planning, operation, maintenance, process monitoring,) **B部分：对设计方、技术实施办公室、业主和运营者进行培训，包括考察和在德国的现场培训（关于沼气工程设计、运营、维修、过程监控）**

Component C: Sector policy support: Recommendation to **C部分：行业政策支持**
(a) Improve the technical standard of biogas plants in China, by **提高中国沼气工程技术标准**
(b) Awarding the project performance and output rather the initial investment, **支持项目运行和产品而不是初期投资**
(c) China Biogas Handbook, etc. **中国沼气手册**

Component D: Review of project concept (FSR) of ADB subprojects acc. RRP Annex 9, on a 'voluntary basis' to subproject s which want advise from the GTZ experts team (acc. to ADB technical standard, review of detail planning and specification of equipment for tendering). **D部分：根据自愿原则对ADB子项目可研进行评估（根据亚行技术标准，详细设计评估，招标设备规格）**



ADB Subproject Review and Approval Process (acc. Draft RRPP 10/2009) / ADB子项目审查和批准程序

Step	Responsible Party	Action	Standard or Criteria
1	Provincial PIO	Screen subprojects	Subproject Selection Criteria
2	Subborrower	Prepare subproject documents: 1. FSR 2. Tabular environmental impact report	1. Design Standards for Biogas Projects in Large Livestock Breeding Farms (NY/T1222-2006) 2. PRC Environmental Impact Assessment Law
3	Municipal/County government through local project office	Endorse subproject: 1. Financial capacity 2. Subloan guarantee	
4	Provincial government through PIO	Review and approve subproject: 1. FSR—financial and economic viability 2. Initial environmental examination	1. Guidelines for technical specification, performance, implementation, and operation of medium- and large-scale biogas plants under ADB loan 2. Environmental assessment and management framework 3. Subprojects whose base cost of construction is less than CNY15 million
5	Provincial PIO	Prepare provincial FSR	
6	Provincial Development and Reform Commission	Review and approve provincial FSR	
7	ADB	Prior review and no-objection approval of subproject beyond threshold: 1. FSR 2. Initial environmental examination 3. Environmental management plan	1. Subprojects whose base cost of construction is equal to or more than CNY15 million 2. First two subprojects whose base cost of construction is less than CNY15 million in each province

2.1 Design Standards for Biogas Projects in Large Livestock Breeding Farms (NY/T1222-2006)

4.1 Guidelines for technical specification, implementation and operation of medium- and large-scale biogas plants under ADB loan

Annex 4b of PPTA
Report 1/2009



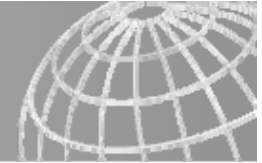


ADB子项目评估和批准程序

步骤	负责方	活动	标准
1	省级项目办公室	选择子项目	子项目选择标准
2	借贷方	准备子项目文件: 1.可行性研究报告 2.环境影响评价报告	1. 大中型养殖场沼气工程设计标准 (NY/T1222-2006) 2. 中华人民共和国环境影响评价法
3	市/县政府通过地方项目办	保证子项目: 经济能力 贷款保障	
4	省政府通过省级项目办	评估和批准子项目: 可行性研究报告—经济可行性 初级环境评估	1. 亚行贷款大中型沼气设计、操作、实施及运行技术规范指南 2. 环境影响评价及管理框架 3. 总投资小于1500万人民币的子项目
5	省级项目实施办公室	准备省级可行性研究报告	
6	省发展和改革委员会	评估和批准省级可行性研究报告	
7	亚洲开发银行	先期评估和为超出界限的子项目出具不反对意见书: 可行性研究报告 初期环境影响评估 环境管理计划	1. 总投资超过1500万人民币的子项目 2. 每个省份前两个投资少于1500万人民币的子项目

PPTA
报告附件 4b
1/2009





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Requirements on MLBGP Plant Design and Operation



Overview - Requirements on MLBGP Plant Design and Operation (Annex 4B) / 大中型沼气厂设计和运转要求 (附件4B)

- (i) Feedstock 给料 (pre-treatment, age, co-feedstock 预处理, 时期, 联合给料)
- (ii) AD technology and process performance 厌氧消化技术和运行情况 (COD removal rate, temperature control, reactor efficiency, HRT, energy saving, 化学需氧量消除, 温度控制, 反应速率, 水解停留时间, 能量节省)
- (iii) Auxiliary Equipment 附属设备 (原料收集设备 feedstock collection equipment, 热交换器 Heat Exchangers, 肥料储存设施 Fertilizer storage facilities, 肥料输送设备 Fertilizer distribution equipment, 气体液化及罐装 Gas liquefaction, compaction and bottling, 气体输送管道 (燃气管网) Local gas distribution grid, 备件 spare parts)
- (iv) Plant Safety 工厂安全 (Explosive Safety Zones 爆炸安全区, gas over- and under pressure safety devices 爆炸, 气体过剩或不足压力安全装置, Other safety measures 其他安全措施)
- (v) Peoples health and hygiene 人身健康和卫生 (feedstock hygienisation 给料卫生)





Overview - Requirements on MLBGP Plant Design and Operation (Annex 4B) / 大中型沼气厂设计和运转要求 (附件4B)

- (vi) Environmental protection and natural disasters 环境保护和自然灾害 (气体排放 gaseous emissions , 噪音 noise, 沼气利用系统的排放, 防洪措施 protection against flooding, 地震 earthquakes)
- (vii) Management aspects 管理方面 (internal and external process control and monitoring, including CDM, management responsibilities and functions , spare parts, maintenance 员工教育和培训, 职责, 备件, 维修)
- (viii) Staff education and training 员工教育与培训
- (ix) Planning and detail design, specification 计划和详细设计 (General Contractor approach , turn-key lots procurement/tender, liability for project performance, safety analysis, 'Heat loss calculations' and 'energy balance' ,)
- (x) Supplies 必须品 (works-, equipment contracts, quarantines 工厂和设备合同, 检疫期)





Overview - Requirements on MLBGP Plant Design and Operation (Annex 4B) / 大中型沼气厂设计和运转要求 (附件4B)

- NY/T 1220.1-2006: Technical standard for biogas engineering Part 1: Process design 沼气工程技术规范，第一部分：工艺设计
- NY/T 1220.2-2006: Technical standard for biogas engineering Part 2: Design of biogas supply 沼气工程技术规范，第二部分：供气设计
- NY/T 1220.3-2006: Technical standard for biogas engineering Part 3: Construction and acceptance 沼气工程技术规范，第三部分：施工及验收
- NY/T 1220.4-2006: Technical Standard for biogas engineering Part 4: Operation and maintenance 沼气工程技术规范，第四部分：运行管理
- NY/T 1220.5-2006: Technical Standard for biogas engineering Part 5: Evaluation of quality 沼气工程技术规范，第五部分：质量评价
- NY/T 1221-2006: Technical Standards for Operation, Maintenance and Safety of Biogas Projects in Large Livestock Animal Breeding and Poultry Farms, 规模化畜禽养殖场沼气工程运行、维护及其安全技术规程
- NY/T 667-2003: Classification of scale for biogas engineering 沼气工程规模划分标准
- NY/T1222-2006: Design Standards for Biogas Projects in Large scale Livestock and poultry breeding farms. 规模化畜禽养殖场沼气工程设计规范



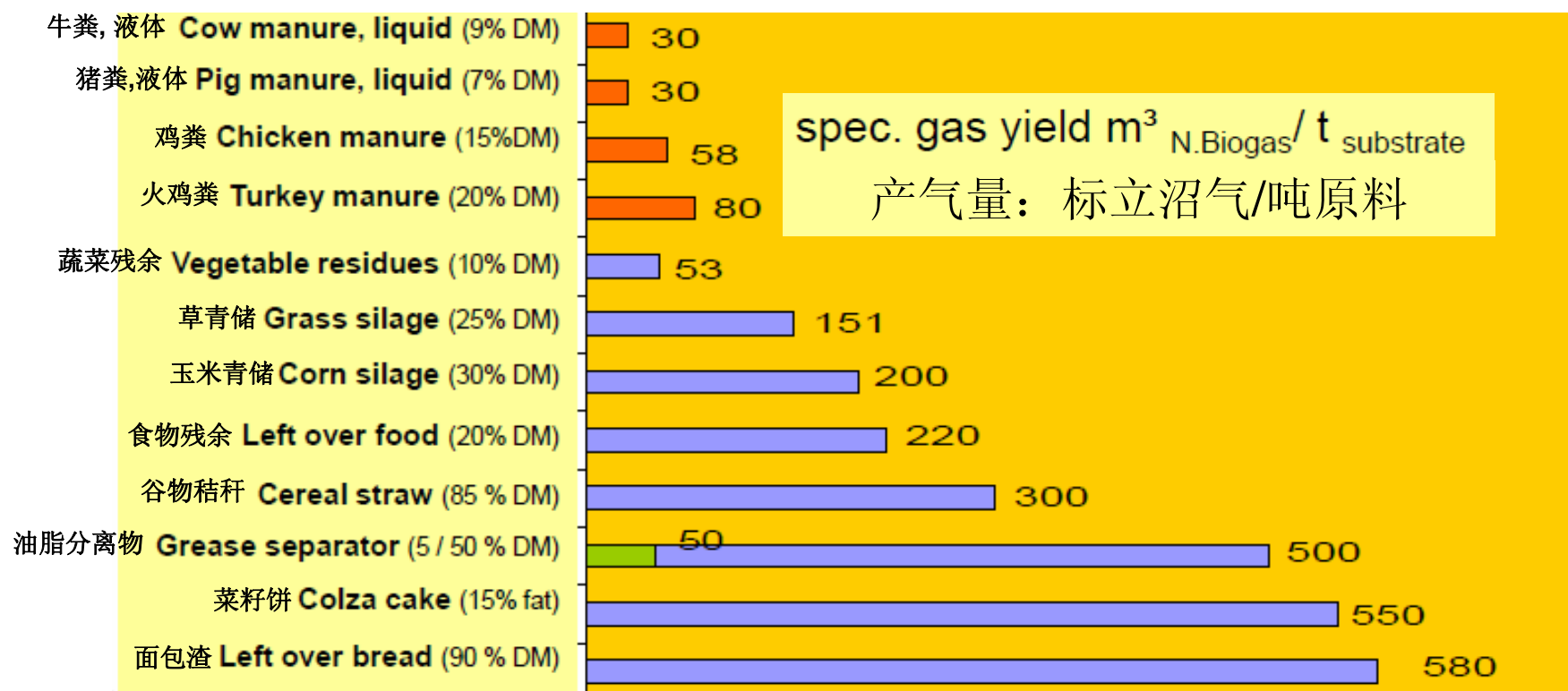


Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

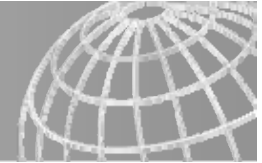
- (i) **Feedstock** (age, co-feedstock, ...) 原料(存储时间, 联合原料...)
- (ii) **AD technology and process performance** 厌氧发酵技术和过程性能
 - **General plant availability** (Technical breakdown) 项目总体可用性 (技术故障)
 - **Fermenter and Pipes** 厌氧罐和管道
 - **COD (VS) destruction/conversion** shall be at least 60%
 - **Temperature control** 0.55° C +/- per day, acc. US standard 温度控制+/-0.55°C每天
 - **Technology related performance criteria** such as: CSRT HRT > 17 days, PFR HRT > 20 days, unheated AD HRT 26d in the South 60d in the North (US standard) 与性能相关的技术标准:
CSTR 停留时间>17天, PFR水力停留时间>20天, 对于无增温措施的厌氧罐水力停留时间: 北方60天, 南方26天(美国标准).



Biogas Yields of Different Feed Stock 不同原料产气量



High biogas yields, more stabile process, better trace element supply, better performance,...

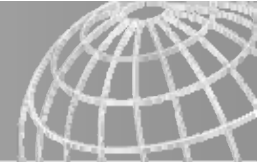


集中式的定义 Definition of ,Centralized‘

,Centralized biogas plants‘ process feedstock from a certain catchment area with the benefit

集中式沼气厂处理从周边一定范围内收购的原料,好处有:

- to operate larger units (than the decentralised solution would be) in a better economic scale 带来项目规模效益
- can be operated with the same type of feedstock (e.g. pig manure + pig manure), or with ,co-digestion‘ (e.g. manure + BMW + energy crops) 可以集中处理同一种原料,或者不同原料混合集中处理
- they usually have a higher process stability 厌氧发酵过程更稳定
- depend less on individual feedstock sources (project partners). 原料供应更稳定



混合原料发酵定义 Definition of 'Co-digestion'

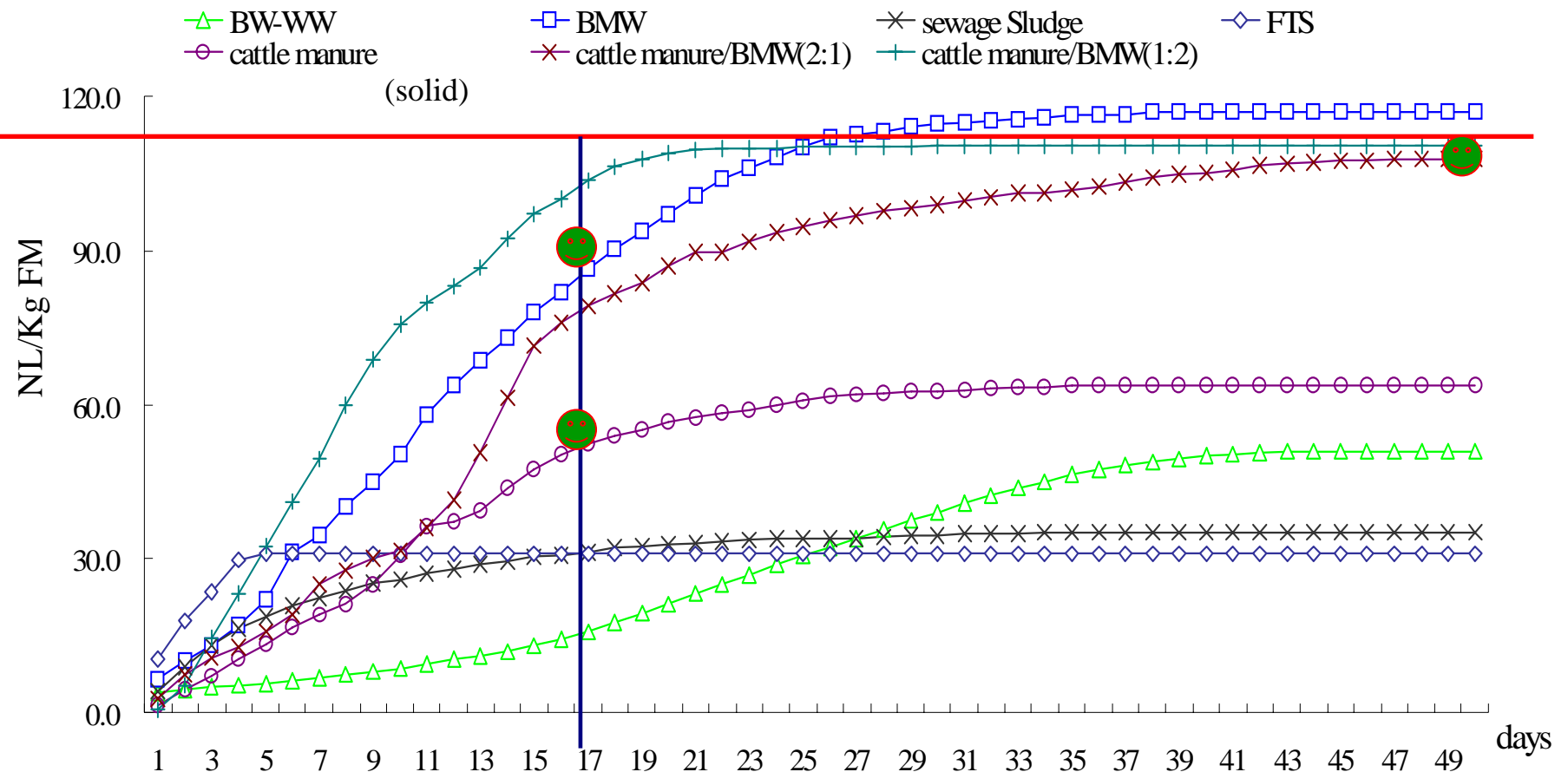
Co-digestion mostly at 'centralized' plants (if it is not an on-site treatment) is to process different kind of feedstock (manure, agroindustrial waste, restaurant and BMW, straw, energy crops,), with the benefit to **混合原料发酵处理不同的原料,好处有:**

- operate larger units in a better economic scale **工程规模效益**
- improve the efficiency of existing facilities (specific biogas production) **提高运行效率 (特别沼气产量)**
- maintain a more stable process (multi feedstock fermenter diet,) **厌氧过程更稳定**
- enhance income situation through receiving waste disposal service fees and higher biogas production (energy sales, CERs,)

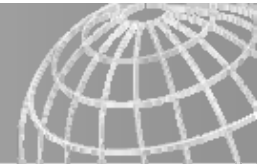
获得垃圾处理收入和更多沼气以提高收入(出售能源,减排量)



Co-fermentation leads to better biogas yields 混合发酵提高沼气产量



High biogas yields, more stable process, better trace element supply, better performance,...



The new conceptual approach to develop MLBGP for Biogas and CDM 沼气厂建设与CDM结合，发展大中型沼气厂的新概念，新方法

Digester Types (US standard)

Plug Flow Digester (PFR)

For cow manure the TS of influent shall be 11 to 14 %.

For other manure sources the TS shall be 8 to 14 %.

HRT > 20 days, temperature mesophilic (35 °C to 40 °C) an optimum of 37.5 °C, daily fluctuation of digester temperature limited to less than 0.55 °C

The length to width ratio of digester flow path shall be between 3.5:1 and 5:1.

The ratio of flow path width to fluid depth shall be less than 2.5:1.

The shape of the floor and walls shall be uniform to minimize mixing.

Complete Mix Digester (CSTR)

TS influent shall be from 2.5 to 10%.

HRT > 17 days.

Temperature mesophilic (35 °C to 40 °C).

Appropriate mixing devices shall be provided to assure a complete mix process.

Fixed Film Digester

TS of influent shall be < 5 %. For TS > 2.5 % (particle size < 0.6 cm).

HRT from 1 to 6 days, depending on waste biodegradability.

Temperature from 15 °C - 40 °C

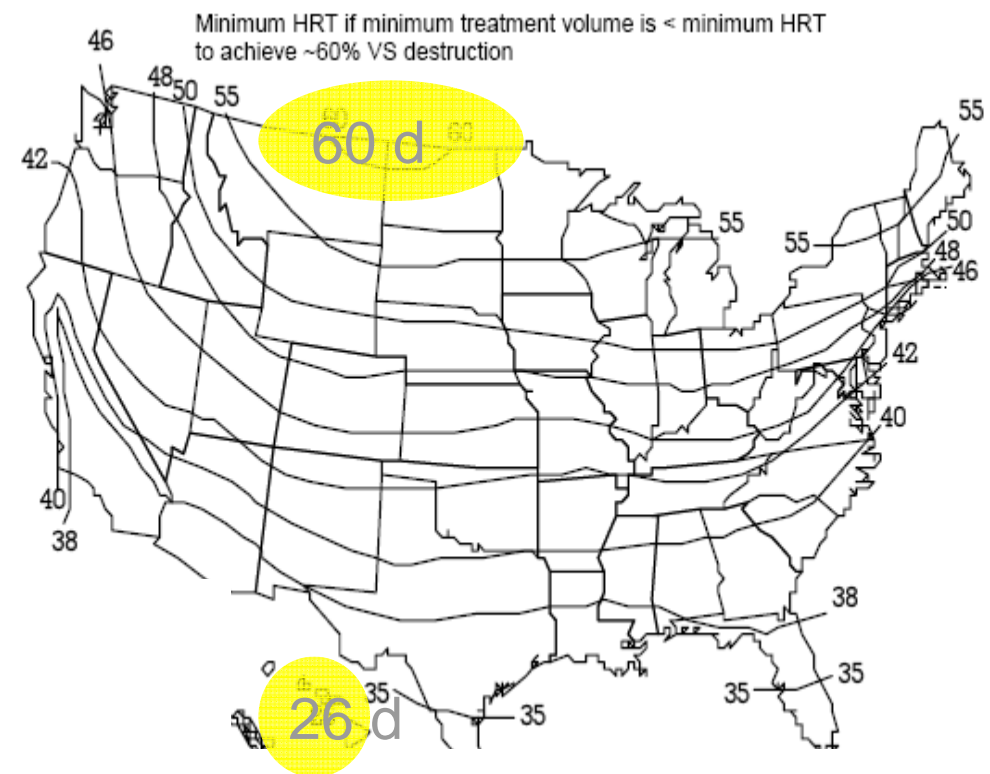
Microbial support material with > 7 cm openings

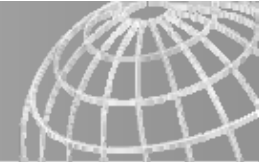


The new conceptual approach to develop MLBGP for Biogas and CDM 沼气厂建设与CDM结合，发展大中型沼气厂的新概念，新方法

➤ Performance aspects

- Timely availability of the installation incl. energy plant 90 – 95%
- VS destruction > 60% (also US standard, see below,)
- Minimum hydraulic retention time (HRT) for covered AD systems in days in US between 60 d in the North and 26 d in the south
- ANAEROBIC DIGESTER – AMBIENT TEMPERATURE (No.) Code 365





Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

• Gas Purification Systems 沼气利用系统

BG desulfurization by ($>350 \text{ mg/m}^3 \text{ SO}_2$ for combustion engines 沼气脱硫(内燃机中 $\text{SO}_2 < 350 \text{ mg/m}^3$):

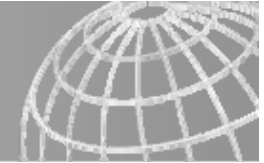
- BG mixed with an air stream ($<12 \text{ Vol\%}$) 生物脱硫 (沼气与空气混合 $< 12 \text{ Vol\%}$), biological desulfurisation
- FE-hydroxide reduction to FeS 氢氧化铁还原
- Active carbon absorption (pressure swing absorption, PSA) absorption by scrubbing processes Polyethylene glycol, Cryogenic separation, In-situ methane enrichment anaerobic digestion acceleration (ADA) 活性炭吸附 (同时过滤沼气中其他痕量杂质) 厌氧发酵加速法(ADA®)



▪ Electricity stand-by capacity 发电备用能力

▪ Electricity grid geeding 发电上网

▪ Emergency high-temperature gas flare $>1200^\circ \text{ C}$ and a residence time of $>0.3 \text{ s}$ (USA $0.6-1\text{s}$ $>850^\circ \text{ C}$) 紧急高温气体火炬: 火焰温度要求 $>1200^\circ \text{ C}$, 停留时间应该 $> 0.3 \text{ 秒}$ (美国要求 $0.6 - 1 \text{ 秒}, >850^\circ \text{ C}$)



CEFPF support ADB projects to install High Temperature Gas flares 清洁能源伙伴基金支持亚行项目建设高温气体火炬

Biogas flares destroy the biogas which cannot be used during: - overproduction, - problems with the gas utilization system. Emission reduction through flares is eligible for CDM CER generation. 火炬焚毁未能利用的沼气（生产过量，气体利用系统故障时），火炬减排量可以成为合格的CDM 减排





Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

(iii) Auxiliary Equipment 附属设备

- Spare parts 备件
- Waste collection equipment 原料收集设备
- Heat exchangers 热交换器
- Fertilizer storage facilities 肥料储存设施
- Fertilizer distribution equipment 肥料输送设备
- Gas liquefaction and bottling 气体液化及罐装
- Local gas distribution pipelines (gas grid) 气体输送管道 (燃气管网)



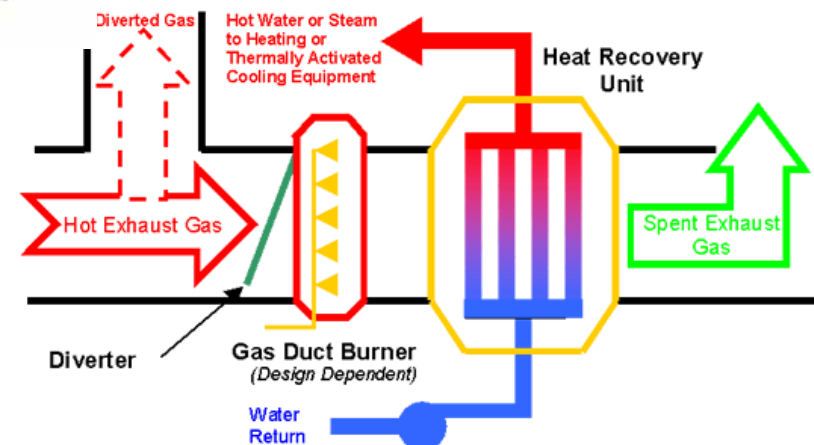


Heat exchangers / 热交换器

Different Types of heat exchangers (spiral, pipe-in pipe,) to recover (waste) heat from liquid and gaseous media 不同类型的可以从液体或气体中回收热量的热交换器

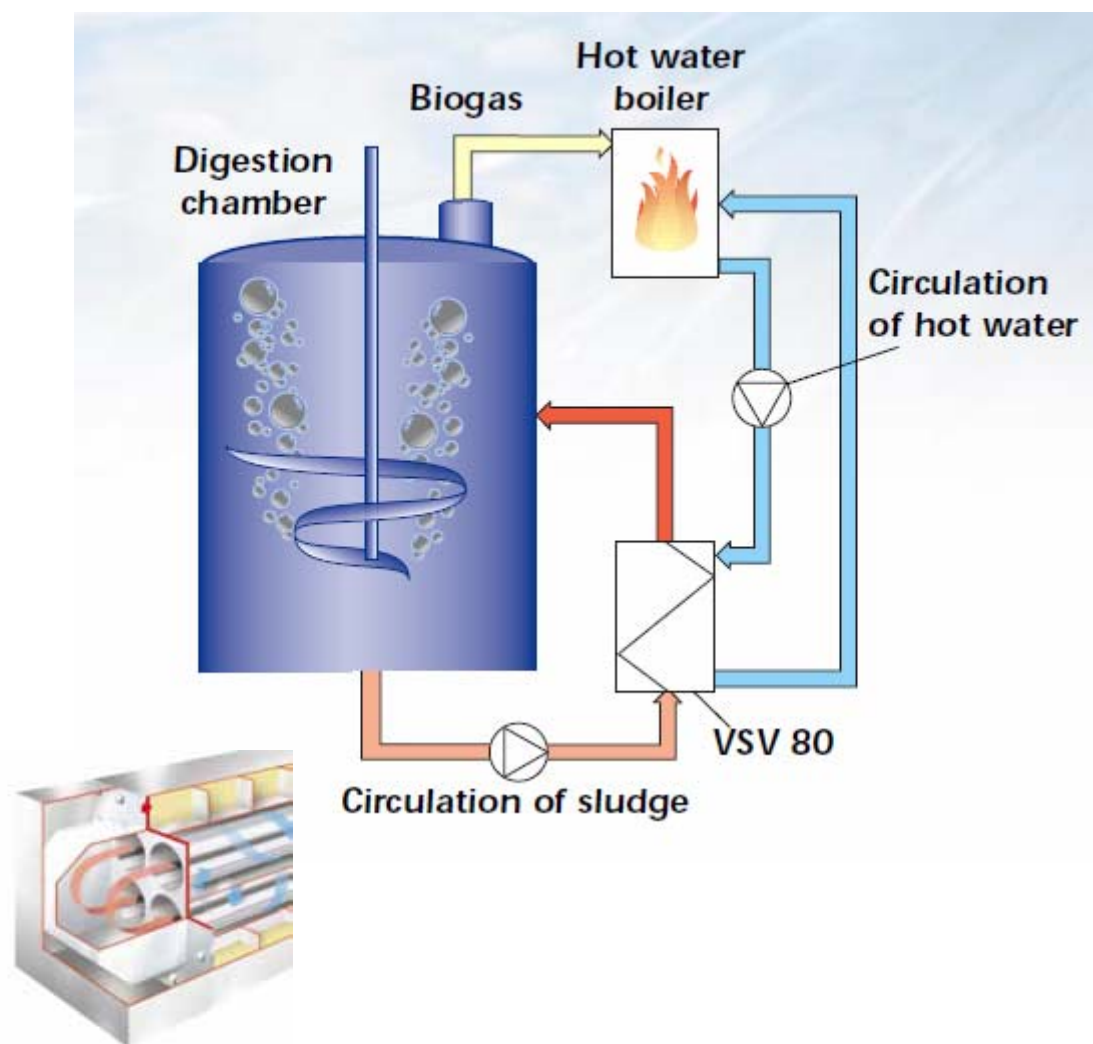


At MLBGP's heat exchangers contribute to energy saving by for example converting the heat from the warm AD effluent to the AD influx, or to utilize the heat from CHP to heat the fermenter (with hot water or steam). 热交换器节约了沼气工厂能源，比如可以将厌氧罐出料中的热量转移到进料，或者将热量从CHP转移到厌氧罐（利用热水或蒸汽）。





Heat exchangers / 热交换器



Example VSV 40

Sludge flow	6 m ³ /h
Sludge temperature at inflow	5.0°C
Sludge temperature at outflow	31.0°C
Hot water flow	8 m ³ /h
Water temperature at inflow	75.0°C
Water temperature at outflow	55.0°C
Effect	183 kW
<i>Application for heating of incoming sludge.</i>	

Example VSV 80

Sludge flow	73 m ³ /h
Sludge temperature at inflow	55.0°C
Sludge temperature at outflow	55.6°C
Hot water flow	12 m ³ /h
Water temperature at inflow	68.0°C
Water temperature at outflow	64.1°C
Effect	55 kW
<i>Application for maintaining constant temperature.</i>	



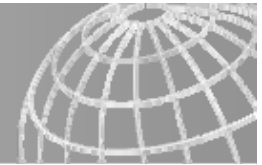
Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

(iv) Plant Safety 厂区安全



- **Explosion protection** 爆炸保护
- **Over- and under pressure safety** 过压及负压保护
- **Emergency gas release** 紧急气体排放
- **Flame trap device** 阻火器
- **Explosive safety zones** 爆炸安全区





The new conceptual approach to develop MLBGP for Biogas and CDM 沼气厂建设与CDM结合，发展大中型沼气厂的新概念，新方法(2)

- **Safety aspects** and protective measures incorporated into the design regarding: '*Biogas is a flammable gas*'.

设计中考虑安全和防护措施

- Explosion (ca. 6 – 12 Vol. % Biogas, 4,4 – 16,5 Vol.% Methane)
- Fire (ca. 700 ° C, Methane 595 ° C)

The gas collection, control, and utilization system shall be accordance with standard engineering practice for handling a flammable gas and to prevent undue safety hazards.

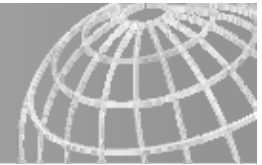
As a minimum:•

“Warning Flammable Gas” and “No Smoking” signs shall be posted.

Flares shall be grounded or otherwise protected to minimize the chance of lightning strikes.

A flame trap device shall be provided in the gas line between the digester and sources of ignition or as recommended by the flame arrester manufacturer.

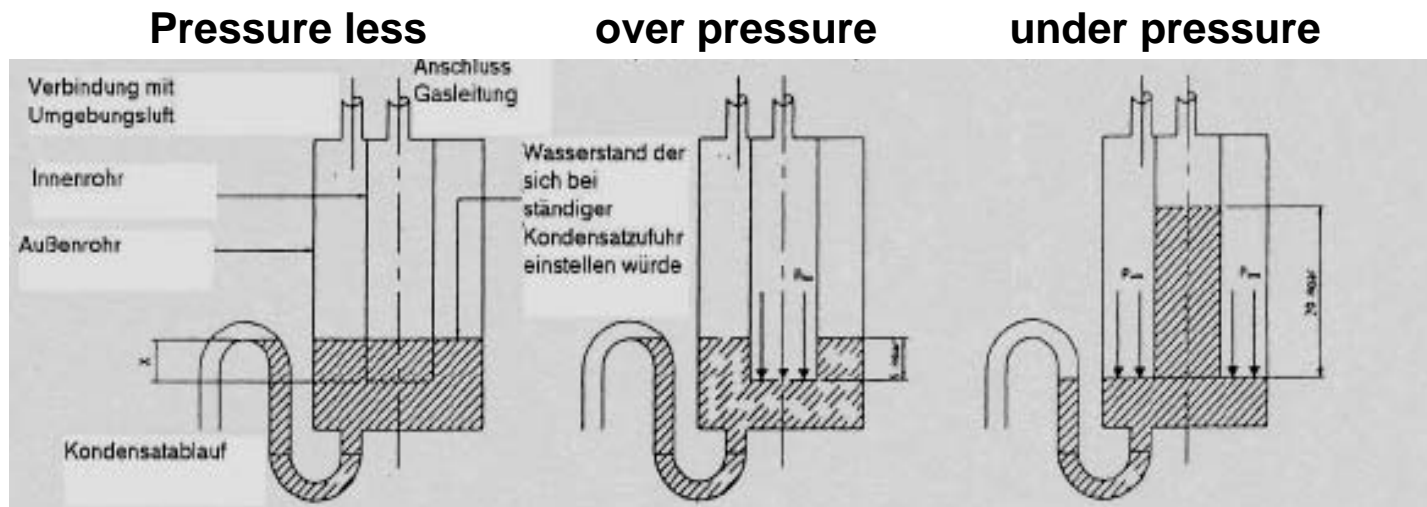
The location of underground gas lines shall be marked with signs to prevent accidental disturbance or rupture. Mark exposed pipe to indicate whether gas line or other



The new conceptual approach to develop MLBGP for Biogas and CDM 沼气厂建设与CDM结合，发展大中型沼气厂的新概念，新方法(2)

> Safety equipment 安全设备

Over- and under pressure safety device (at least one) for each container holding biogas (fermenter, gas holder,), protected to the discharge of the sealing liquid at the stage of over- or under pressure), in the case of emergency the gas must be released to open air at least 3m above ambient ground, 1 m above buildings and 5m from neighboring facilities, in 1 m distance from the container content





Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

(v) Peoples health and hygiene 人员健康和卫生

- **Feedstock hygienisation animal products: particle size <12 mm, 60 min at 70° C** 原料卫生化处理 动物产品: 粒径<12 mm, 70° C下熟化60分钟

(vi) Environmental protection and natural disasters 环境保护和自然灾害

- **Gaseous emissions (GHG, toxic gases, odor)** 气体排放 (温室气体, 有毒气体, 臭味)
- **Noise (mainly from gas engines)** 噪音 (主要来自燃气发动机)
- **Emissions from gas utilization (boiler, CHP and flare emissions)** 沼气利用系统的排放 (锅炉, CHP和火炬排放)



Requirements on MLBGP Plant Design and Operation (ANNEX 4B) 大中型沼气工程设计和运行要求和条件 (附件4B)

(vii) Management 管理



- Allocation of staff responsibilities 员工职责分配
- Periodically internal and external inspection of electric- and electronic equipment, process monitoring by plant operator 定期的内部和外部检查电气和电子设备，过程监测
- MLBGP have to be controlled by an overall process control system 大中型沼气工厂必须由一套整体过程控制系统控制

(viii) Staff education and training 员工教育与培训

(ix) Planning and design 规划与设计

(x) Supplies (works and equipment) 供应（工程及设备）





Check List (Annex 4B - 6) / 核查清单 (附件4B – 6)

核查清单: 大中型沼气工程设计和运行要求 (为“技术提高必要性评估”及基于详细设计的额外投资估计准备的文件)

Check list: Requirements on MLBGP plant design and operation for a comprehensive ‘technical upgrade needs assessment’ and estimation of additional costs based on detailed project design (70 criteria)

	要求类别 Item required: 部分 A PART A:	Relevant to the project (Yes/no) 是否与项目相关 (是/否)	Considered in the FSR (Yes/no) 是否考虑到可研中 (是/否)	Additional costs required (CHY) 需要增加的投资 (人民币)	Comments 解释
1.	Wet feedstock bioorganic wastes with low lignocelluloses content 低木质素含量的生物湿有机废弃物				
2.	Age of feedstock less than 7 days (if not deep frozen) 原料存储时间少于 7 天 (如果没有深度冷冻)				
3.	Low content on ‘ballast matter’ 沙石含量低				
4.	‘Clean pollution free - feedstock’ 原料无污染				
5.	Co- feedstock available 存在联合发酵原料				
6.	General plant operation availability of >90 - 95% (>8000 h/yr) 工程年运行时间大于每年总时间的 90 - 95% (>8000 h/yr)				





Thank You! 谢谢 !

**Technical Director
Optimization of Biomass Utilization Project**
生物质能项目主任 :

Prof. Dr. Bernhard Raninger
bernhard.raninger@gtz.de
GTZbiogas@126.com



Straw & Stalk Biomass Resources in China 2006 (mn t/yr) 24 GW in 2020 !!

	Total straw and stalk output	Fertilizer / collection loss	Use as fodder	Use as paper raw material	Use as fuel (cooking & heating)	Others
East China	184.759	27.715	42.125	4.291	110.628	
South China	147.503	22.126	56.296	7.170	61.911	
Northeast China	100.646	15.097	1.934	2.579	63.636	17.400
North China	86.786	13.018	13.646	3.105	57.017	
Southwest China	82.666	12.400	41.555	2.112	26.599	
Northwest China	45.566	6.836	4.910	1.744	26.518	5.558
total	647.926	97.192	160.466	21.001	346.309	22.958

